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	First Named Inventor	Hidaeki Kuwabara	
	Group Art Unit	2879	
	Examiner Name	Matthew P. Hodges	
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ENCLOSURES (check all that apply)		
<input type="checkbox"/> Fee Transmittal Form <input type="checkbox"/> Fee Attached <input type="checkbox"/> Amendment / Reply <input type="checkbox"/> After Final <input type="checkbox"/> Affidavits/declaration(s) <input type="checkbox"/> Extension of Time Request <input type="checkbox"/> Express Abandonment Request <input type="checkbox"/> Information Disclosure Statement <input type="checkbox"/> Certified Copy of Priority Document(s) <input type="checkbox"/> Response to Missing Parts/Incomplete Application <input type="checkbox"/> Response to Missing Parts under 37 CFR 1.52 or 1.53	<input type="checkbox"/> Assignment Papers (for an Application) <input type="checkbox"/> Drawing(s) <input type="checkbox"/> Declaration and Power of Attorney <input type="checkbox"/> Licensing-related Papers <input type="checkbox"/> Petition <input type="checkbox"/> Petition to Convert to a Provisional Application <input type="checkbox"/> Power of Attorney, Revocation Change of Correspondence Address <input type="checkbox"/> Terminal Disclaimer <input type="checkbox"/> Request for Refund <input type="checkbox"/> CD, Number of CD(s) _____	<input type="checkbox"/> After Allowance Communication to Group <input type="checkbox"/> Appeal Communication to Board of Appeals and Interferences <input type="checkbox"/> Appeal Communication to Group (Appeal Notice, Brief, Reply Brief) <input type="checkbox"/> Proprietary Information <input type="checkbox"/> Status Letter <input type="checkbox"/> Application Data Sheet <input type="checkbox"/> Request for Corrected Filing Receipt with Enclosures <input type="checkbox"/> A self-addressed prepaid postcard for acknowledging receipt <input checked="" type="checkbox"/> Other Enclosure(s) (please identify below): 1. Submission of Verified Translation of Priority Document 2. Verification of Translation 3. English Language Translation of Japanese Patent Application No. 2002-265023.
Remarks		<input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees required or credit any overpayments to Deposit Account No. 19-2380 for the above identified docket number.

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Signature	
Date	February 16, 2006

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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

The Patent Application of: ) Confirmation No. 4101  
Hidaeki Kuwabara )  
Application No. 10/659,427 ) Examiner: Matthew P. Hodges  
Filed: September 11, 2003 ) Group Art Unit: 2879  
For: LIGHT-EMITTING APPARATUS AND )  
FABRICATION METHOD OF THE )  
SAME ) Date: February 16, 2006

**SUBMISSION OF VERIFIED TRANSLATION OF PRIORITY DOCUMENT**

**MAIL STOP AMENDMENT**

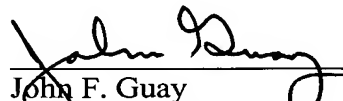
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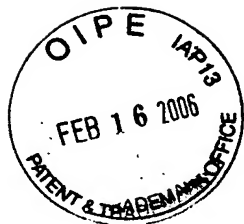
Further to the response filed on January 9, 2006, Applicants submit herewith a verified translation and a Verification of Translation of Japanese Patent Application Serial No. 2002-265023. This submission perfects Applicants' claim for benefit of priority under 35 U.S.C. §119. Thus, the rejections of claims 1-5, 7-9, 14, 26-29, 31, 34-37 and 39-43 based on U.S. Patent Application Publication Nos. US 2003/0184217 and US 2003/0227021 are overcome.

It is believed the application is in condition for immediate allowance. Prompt notification of the same is earnestly solicited.

Respectfully submitted,

  
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Docket No.: 740756-2649

IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re Patent Application of: )  
Hideaki KUWABARA )  
Application No.: 10/659,427 ) Art Unit: 2879  
Filed: September 11, 2003 ) Examiner: Matthew P. Hodges  
For: LIGHT EMITTING DEVICE AND FABRICATION METHOD OF THE SAME )

VERIFICATION OF TRANSLATION

Honorable Commissioner of Patents and Trademarks  
Washington, D.C. 20231

Sir:

I, Akiko Nishimura, Flat SEL F513, 309-1, Atsugi-shi, Kanagawa-ken 243-0036 Japan, a translator, herewith declare:

that I am well acquainted with both the Japanese and English Languages;

that I am the translator of the attached translation of the Japanese Patent Application No. 2002-265023 filed on September 11, 2002; and

that to the best of my knowledge and belief the followings is a true and correct translation of the Japanese Patent Application No. 2002-265023 filed on September 11, 2002.

I further declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under Section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

Date: this 14<sup>th</sup> day of February 2006

Akiko NISHIMURA

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[Attachment] Specification  
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[Title of the invention]

**LIGHT EMITTING DEVICE AND MANUFACTURING METHOD OF THE SAME**

[Scope of Claim]

[Claim 1]

A light emitting device comprising a light emitting element having a first electrode, a layer containing an organic compound which contacts the first electrode, and a second electrode which contacts the layer containing an organic compound over a substrate having an insulating surface, wherein a first bank covering an edge portion of the first electrode and a second bank serving as a side wall of the first bank are included.

[Claim 2]

The light emitting device according to claim 1, wherein a material for the first bank is different from that for the second bank.

[Claim 3]

The light emitting apparatus according to claim 1 or 2, wherein a material for the first bank is an inorganic insulating material and a material for the second bank is an organic insulating material.

[Claim 4]

A light emitting device according to any one of claims 1 to 3, wherein a material for the first bank is a hydrophobic material and a material for the second bank is a hydrophilic material.

[Claim 5]

A light emitting device comprising a light emitting element having a first electrode, a layer containing an organic compound which contacts the first electrode, and a second electrode which contacts the layer containing an organic compound over a substrate having an insulating surface, wherein a first bank covering an edge portion of the first electrode, a second bank covering the first bank, a layer containing an organic compound on the first electrode, and a second electrode on the layer containing an organic compound are included; and

wherein the second bank is provided between the layer containing an organic compound and the first bank.

[Claim 6]

The light emitting device according to claim 6, wherein a material for the first bank is an inorganic material.

[Claim 7]

The light emitting device according to claim 5 or 6, wherein a material for the first bank and a material for the second bank are different from each other.

[Claim 8]

The light emitting device according to claim 5 or 6, wherein a material for the first bank and a material for the second bank are the same.

[Claim 9]

A light emitting device comprising a light emitting element having a first electrode, a layer containing an organic compound which contacts the first electrode, and a second electrode which contacts the layer containing an organic compound over a substrate having an insulating surface,

wherein a first bank formed of an oxide and covering a wire or an electrode, a second bank serving as a side wall of the first bank, a layer containing an organic compound on the first electrode, and a second electrode on the layer containing an organic compound are included.

[Claim 10]

The light emitting device according to any one of claims 1 to 9, wherein an irregularity in a first electrode surface which contacts an organic compound layer is smaller than that in a first electrode surface covered with a first bank.

[Claim 11]

The light emitting device according to any one of claims 1 to 10, wherein an irregularity in a region which contacts the second bank within the first electrode is smaller than that in a first electrode surface which contacts a first bank.

[Claim 12]

A manufacturing method of a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound and contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface, comprising the steps of:

- forming a TFT and a first electrode over a substrate at a first site and forming an organic resin film or an inorganic insulating film so as to cover the first electrode over a whole surface;

- transporting a substrate to a second site;

- forming a bank by etching the organic resin film or the inorganic insulating film at the second site and after exposing a part of the first electrode, forming a layer containing an organic compound on the first electrode without exposing to air; and

- forming a second electrode on the layer containing an organic compound.

[Claim 13]

A manufacturing method of a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound and contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface, comprising the steps of:

- forming a TFT and a first electrode over a substrate at a first site and forming a first bank covering an edge portion of the first electrode;

- polishing an exposing surface of a first electrode;

- forming an organic resin film or an inorganic insulating film so as to cover the first electrode and the first bank over a whole surface;

- transporting a substrate to a second site;

- forming a second bank by etching the organic resin film or the inorganic insulating film at the second site and after exposing a pixel electrode, forming a layer containing an organic compound on the first electrode without exposing to air; and

- forming a second electrode on the layer containing an organic compound.

[Claim 14]

A manufacturing method of a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound and contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface, comprising the steps of:

- forming a TFT and a first electrode over a substrate at a first site and forming an organic resin film or an inorganic insulating film and an antistatic layer to stack so as to cover the first electrode on a whole surface;

- transporting a substrate to a second site;

- etching the antistatic layer at the second site and etching the organic resin film or the inorganic insulating film to form a bank and after exposing a part of the first electrode, forming a layer containing an organic compound on the first electrode without exposing to air; and

forming a second electrode on the layer containing an organic compound.

[Claim 15]

A manufacturing method of a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound and contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface, comprising the steps of:

forming a TFT and a first electrode over a substrate;

forming a first bank having a hydrophobic surface so as to cover an edge portion of the first electrode;

forming a second bank having a hydrophilic surface on a side face of the first bank, and

forming a layer containing an organic compound so as to contact only a second bank and a first electrode by coating.

[Claim 16]

The manufacturing method according to claim 15, wherein the coating is spin-coating or ink-jetting.

[Detailed Description of the Invention]

[0001]

[Field to which the Invention pertains]

The present invention relates to a light emitting device using a light emitting element which emits fluorescence or phosphoresce by applying an electric field to the element, provided with a layer containing an organic compound (hereinafter referred to as an "organic compound layer") sandwiched between a pair of electrodes, and to a manufacturing method thereof. In this specification, the term light emitting device means an image display apparatus, a light-emitting device, or a light source (including a lighting system). In addition, the following modules are included in the light emitting device: a module obtained by attaching a connector such as an FPC (Flexible printed circuit), a TAB (Tape Automated Bonding) tape, or a TCP (Tape Carrier Package) to a light emitting device; a module obtained by providing a printed wiring board with a tip of a TAB tape or a TCP; and a module obtained by mounting directly an IC (integrated circuit) to a light emitting element by COG (Chip On Glass) system.

[0002]

[Prior Art]

A light emitting element using an organic compound as a luminous body, which is characterized by their thinness and light weight, fast response, and direct current low voltage driving, and so on, is expected to be applied to next-generation flat panel displays. Particularly, a display device in which light emitting elements are arranged in matrix has been considered to be superior to conventional liquid crystal display devices for their wide viewable angle and excellent visibility.

[0003]

The luminescent mechanism of a light emitting element is as follows: electric field is applied to a pair of electrodes that sandwich an organic compound layer, and electrons injected from a cathode and holes injected from an anode are re-combined at the luminescent center of the organic compound layer to form molecular excitons, and then the molecular excitons return to a ground state while radiating energy, consequently, luminescence radiation takes place in the organic compound layer. Known excitation states are an excited singlet state and an excited triplet state.

The luminescence radiation has been considered to be able to take place by reverting from either state to the ground state.

[0004]

A light emitting device constructed of a plurality of the light emitting elements being arranged in matrix may be operated by a driving method such as a passive matrix drive (a simple matrix drive) and an active matrix drive (an active matrix type). However, when pixel density increases, it may be preferable to use an active matrix type in which a switch is provided in each pixel (or each dot) because it can be driven at a low voltage.

[0005]

In the case of manufacturing an active matrix type light emitting device, a TFT is formed over a substrate having an insulating surface as a switching element and an EL element that includes a pixel electrode connected electrically to the TFT as an anode or a cathode is formed in matrix.

[0006]

In a manufacturing factory where a TFT is formed over a substrate having an insulating surface and a manufacturing factory where an integrated circuit is formed over a semiconductor substrate, manufacturer pay an attention to keep the factory in high cleanliness and to prevent impurities from being mixed into a delicate device. Particularly, they pay an attention to prevent an alkali metal element that gives a semiconductor device an adverse effect.

[0007]

On the other hand, for forming an EL element, it is preferable that a material having a small work function, especially, an alkali metal element is used as a cathode, and it is necessary to form a layer containing an organic compound as a light emitting layer.

[0008]

Therefore, in the case of manufacturing a TFT and an EL element over a substrate, it is possible that an installation site of equipment for manufacturing a TFT and an installation site of equipment for forming an EL element are separated from each other. For example, to use different purifiers by providing a partition between devices, to separate buildings in which respective equipment are installed, or to install a factory itself in different sites can be considered.

[0009]

In the case of separating, necessity to transport a substrate between these installation sites occurs. In addition, in transporting the substrate between the installation sites, there is a risk of electrostatic breakdown and adhesion of dust.

[0010]

Further, since a substrate, an organic insulating film, an inorganic insulating film, and the like are insulators, static electricity is easily charged in a surface thereof. Due to this, there is a threat of adhesion of dust on the charged-surface or generating electrostatic discharge if they contact another object.

[0011]

Since a layer containing an organic compound which serves as a light emitting layer has thin thickness, poor coverage tends to occur if irregularity in the surface is large, that is, if difference in level is large.

[0012]

[Means for Solving the Problem]

The present invention relates to forming a bank having a novel structure to solve the above-mentioned problem. The present invention is, as one example thereof shown in FIG. 1B, a



light emitting device including a light emitting element having a first electrode, a layer containing an organic compound and which contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface, wherein a first bank covering an edge portion of the first electrode and a second bank serving as a side wall of the first bank are included.

[0013]

According to the above-mentioned structure, poor coverage can be reduced by the second bank even if an upper portion of the first bank is formed to be narrow. In order to improve the definition of an active matrix display device or a passive matrix display device, upper portions of the banks also need to be reduced. In a case where dry etching is carried out using inorganic insulating film or nonphotosensitive resin as a material for the first bank, a high-definition pattern can be achieved while a side face of the first bank becomes rough or an angle between the side face and a substrate (a taper angle) may be made too large. In view of the foregoing, the second bank covering only both side faces of the first bank is formed to cover the rough portions of the both side faces and to form a smooth surface.

[0014]

As materials for the first bank and the second bank, an inorganic material (silicon oxide, silicon nitride, silicon oxynitride, a SiOF film, a SiONF film, or the like) obtained by sputtering, PCVD, or coating, a photosensitive or nonphotosensitive organic material (polyimide, acrylic, polyamide, polyimideamide, resist, or benzocyclobutene) formed by coating, or a layer obtained by stacking them can be appropriately used. Either a negative type that become an insoluble material to etchant by photosensitive light or a positive type that become dissoluble to etchant by light can be used as an insulator. In addition, insulation between electrodes can be performed only by the first bank, therefore, the insulation performance can be in particular low, and as another material for the second bank, a semiconductor material (including a doped semiconductor material) can be used as well.

[0015]

Further, the first bank and the second bank may be formed of the same material, however, it is preferable to use different materials. In the case where an a layer containing an organic compound is formed by vapor deposition, an evaporation mask and the first bank contact each other, therefore, the height (thickness) of the first bank is preferably equal to or less than 1  $\mu\text{m}$  (more preferably, from 0.5 to 1  $\mu\text{m}$ ) in order to prevent the wrap-around of the vapor deposition. Since it is difficult to form a thin film using an organic material, it is preferable to use an inorganic material.

In the case where a bank is formed of a photosensitive resin by exposure, an upper portion is formed to have a curved surface, and a bottom has a width (width of one side of the bank) of 5  $\mu\text{m}$  or more than that, which is spread from the upper portion. Consequently, the bank has equal to or more than 10  $\mu\text{m}$  in the width in total, and an aperture ratio is reduced accordingly. According to the present invention, a narrow width bank can be formed, for example, a first bank of 1  $\mu\text{m}$  in width and a second bank of 1  $\mu\text{m}$  in width can be formed to be a bank of 3  $\mu\text{m}$  in width in total. The width of the second bank may be 0.1  $\mu\text{m}$  or more than that, however, it is preferable to be larger than the height of the first bank. The width of the second bank is enough to be about 3  $\mu\text{m}$  in order to obtain sufficient coverage. By obtaining coverage, reliability of a light emitting device on its whole is improved. In addition, a radius of curvature of the upper portion of the second bank may be from 0.5 to 2  $\mu\text{m}$ .

[0016]

The present invention can be applied to either of an active matrix display device or a passive

matrix display device. The present invention is particularly useful for a bottom emitting type active matrix display device in which an aperture ratio, namely, a luminous area tends to be lowered due to a TFT or a wiring.

[0017]

Further, it is possible to insulate between electrodes by the second bank instead of the first bank. For example, such a structure may be employed as well that a first bank is formed to cover an edge portion of an electrode of a TFT and a second bank is formed to cover a difference portion in level of a region where the electrode of the TFT and a first electrode are overlapped.

[0018]

Further, in the case where a layer containing an organic compound is formed by coating such as ink-jetting or spin-coating, as one example thereof shown in FIG. 1B, by using a hydrophilic organic material as a material for a second bank and using a hydrophobic inorganic material as a material for a first bank, a layer containing an organic compound is not formed on the first bank, and can be selectively formed on a first electrode or to contact only the second bank.

[0019]

A structure of the present invention relating to a manufacturing method disclosed in this specification is a manufacturing method of a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound and contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface. The manufacturing method comprises the steps of forming a TFT and a first electrode over a substrate, forming a first bank having a hydrophobic surface so as to cover an edge portion of the first electrode, forming a second bank having a hydrophilic surface on a side face of the first bank, and forming a layer containing an organic compound so as to contact only a second bank and a first electrode by coating.

[0020]

Further, a first bank may be covered with a second bank. As one example thereof shown in FIG. 4A, the invention is a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound and contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface, wherein a first bank covering an edge portion of the first electrode, a second bank covering the first bank, a layer containing an organic compound on the first electrode, and a second electrode on the layer containing an organic compound, wherein the second bank is provided between the layer containing an organic compound and the first bank.

[0021]

In the above-mentioned structure, the first bank is completely covered with the second bank, and an upper edge portion of the second bank is more rounded than that of the first bank. According to the structure, the poor coverage may be reduced by the second bank even if the upper surface shape of the first bank is formed to be narrow.

[0022]

In addition, in the case where a TFT and an EL element are manufactured over a substrate, it is preferable to separate an installation site of equipment for manufacturing the TFT and an installation site of equipment for manufacturing the EL device from each other in order to prevent contamination. In transporting a substrate between these installation sites, delivery or transport of the substrate is preferably carried out at a step after forming an insulating film serving as a first bank on a whole surface.

[0023]

A structure relating to a manufacturing method of the present invention is a manufacturing method of a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound and contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface, comprises the steps of forming a TFT and a first electrode over a substrate at a first site and forming an organic resin film or an inorganic insulating film so as to cover the first electrode over a whole surface, transporting a substrate to a second site, forming a bank by etching the organic resin film or the inorganic insulating film at the second site and after exposing a part of a first electrode, forming a layer containing an organic compound on the first electrode without exposing to air, and forming a second electrode on the layer containing an organic compound.

[0024]

In addition, it is preferable that before transporting the substrate to the second side, an antistatic layer for covering the organic resin film or the inorganic insulating film be formed in order to prevent electrostatic breakdown.

[0025]

Further, a first electrode surface may be polished or washed after forming a first bank. Another structure relating to a manufacturing method of the present invention is a manufacturing method of a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound and contacts the first electrode, and a second electrode contacts the layer containing an organic compound, over a substrate having an insulating surface, comprises the steps of forming a TFT and a first electrode over a substrate at a first site and forming a first bank covering an edge portion of the first electrode, polishing an exposing surface of a first electrode, forming an organic resin film or an inorganic insulating film so as to cover the first electrode and the first bank over a whole surface, transporting a substrate to a second site, forming a second bank by etching the organic resin film or the inorganic insulating film at the second site and after exposing a pixel electrode, forming a layer containing an organic compound on the first electrode without exposing to air, and forming a second electrode on the layer containing an organic compound.

[0026]

By polishing or washing, in the first electrode surface, a region except a region covered with the first bank becomes flat and clean. That is, in each above-mentioned structure, irregularity of the first electrode surface contacting the layer containing an organic compound is smaller than that of the first electrode surface covered with the first bank. Then, an insulating film is formed to cover a whole surface, and anisotropic etching is carried out on the insulating film so that the second bank is formed in a self-aligning manner and the first electrode surface is exposed. Although it is possible to use a mask for forming the second bank, it is preferable that the second bank be formed by anisotropic etching in a self-aligning manner in order to prevent the increase in the number of masks.

[0027]

In addition, in the case where the first electrode surface is polished by CMP using slurry after forming the first bank, the vicinity of a bottom edge portion of the first bank is not polished well. However, it is not matter since the portion is covered with the second bank in the following process. In addition, according to each above-mentioned structure, a region in the first electrode contacting the second bank has smaller irregularity than that of the first electrode surface contacting the first bank.

[0028]

In addition, in the case where a TFT and an EL element are manufactured over a substrate, it is preferable to separate an installation site of equipment for manufacturing the TFT and an installation site of equipment for manufacturing the EL element in order to prevent contamination. In transporting a substrate between the installation sites, delivery or transport of the substrate is preferably carried out at a step after forming an insulating film serving as a second bank on a whole surface. By covering the first electrode surface, dust can be prevented from attaching to a first electrode surface.

[0029]

Further, an electrostatic breakdown can be prevented by forming an antistatic layer which covers an insulating film serving as a second bank. Another structure relating to a manufacturing method of the present invention is a manufacturing method for a light emitting device including a light emitting element comprising a first electrode, a layer containing an organic compound which contacts the first electrode, and a second electrode which contacts the layer containing an organic compound, over a substrate having an insulating surface, comprising the steps of forming a TFT and a first electrode over a substrate at a first site and forming an organic resin film or an inorganic insulating film and an antistatic layer to stack so as to cover the first electrode on a whole surface, transporting a substrate to a second site, etching the antistatic layer at the second site and etching the organic resin film or the inorganic insulating film to form a bank and after exposing a part of the first electrode, forming a layer containing an organic compound on the first electrode without exposing to air, and forming a second electrode on the layer containing an organic compound.

[0030]

An electrostatic breakdown can be prevented by forming an antistatic layer which covers an insulating film serving as a second bank. As the antistatic layer, a conductive coated film, for example, a surface-active agent coated film may be utilized. Also, deposited film formed of a material having composition that inorganic salt such as lithium chloride or magnesium chloride is dispersed into film formation material such as synthetic resin or silicate, or deposited film formed of a material having composition that ion-conducting materials such as polymer electrolyte containing a carboxylic acid group or a sulfonic acid group are dispersed into film formation material such as synthetic resin or silicate, or conductive polymer may be utilized as the antistatic layer. After the transportation of the substrate, the antistatic layer is removed, and anisotropic etching is carried out on the insulating film to form a second bank, and then a layer containing an organic compound is formed.

[0031]

#### [Embodiment Modes of the Invention]

Embodiment modes of the present invention are described hereinafter.

[0032]

#### (Embodiment Mode 1)

The present invention is described here by using an example of an active matrix light emitting device.

[0033]

In FIG. 1A, reference numeral 10 is a substrate, 11 is a first bank, 12 is a second bank, 13 is a first electrode, 14 is a layer containing an organic compound, 15 is a second electrode, 16 is a TFT, and 18 is an insulating film. Note that the electrode 13 serves as an anode of a light emitting element and the second electrode serves as a cathode of the light emitting element in FIG. 1A, however, the invention is not limited to this and the first electrode can serve as a cathode and the second electrode can serve as an anode if materials are selected appropriately.

[0034]

An example of a manufacturing process for obtaining a structure illustrated in FIG. 1A is shown in FIGS. 2A to 2D.

[0035]

The TFT 16 is manufactured over the substrate 10 having an insulating surface. A top gate type TFT is illustrated here; however, the invention is not limited to this and the TFT may be a bottom gate type TFT. The TFT 16 is formed to be an n-channel TFT or a p-channel TFT by a known method. Next, the first electrode 13 which serves as an anode is formed to partially overlap an electrode of the TFT. Here, the first electrode 13 is formed by using a conductive film having a large work function (ITO (Indium tin oxide),  $\text{In}_2\text{O}_3\text{-ZnO}$  (indium oxide zinc oxide alloy), ZnO (zinc oxide), or the like) by wet etching. When the first electrode 13 is patterned, an etching condition or a material is appropriately set so that the first electrode 13 has a selection ratio of the first electrode 13 to the insulating film 18.

[0036]

Subsequently, an insulating film is formed by PCVD, sputtering, or coating over a whole surface, and patterning is carried out to form the first bank 11. The first bank 11 covers an edge portion of the first electrode, wirings, and electrodes, and insulates between electrodes. When a width of the first bank 11 is large, aperture ratio is decreased. Therefore, the present invention increases the aperture ratio and improves definition by forming an upper shape of the first bank to small as much as possible. Therefore, the patterning is preferably carried out by dry etching that enables microfabrication. When the first bank 11 is patterned, an etching condition or a material is appropriately set so that the first bank 11 has a selection ratio to the first electrode and the insulating film 18.

[0037]

Then, an exposed surface of the first electrode 13 is polished or washed. FIG. 2A is a cross-sectional view of one pixel at this stage. It is preferable to wash a surface of the first electrode (anode) with a porous sponge (typically, made from PVA (poly-vinyl alcohol) or nylon) soaked in a surfactant (weak alkaline) to remove dust on the surface. As a washing mechanism, a washing equipment with a roll brush (made from PVA) that turns an axis in parallel with a face of a substrate to touch a surface of the substrate, or a washing equipment with a disc brush (made from PVA) that turns an axis perpendicular to a face of a substrate to touch a surface of the substrate may be used. For example, in the case of using chemical mechanical polishing (CMP), it is preferable that the first bank be formed of an inorganic material that is hard. Even if the first bank which is a projection is provided, a first electrode surface can be polished to be flat. Further, if the height (thickness) of the first bank is 2  $\mu\text{m}$  or more, poor coverage tends to occur, and the periphery of a bottom edge portion of the first bank contacting the first electrode is difficult to be polished. Thus, the height of the first bank is preferably low.

[0038]

The first electrode 13 was subjected to CMP by a CMP device at a state of having projection of 550 nm in height. Planarization was realized at a portion that is 3  $\mu\text{m}$  or more away from the projection. FIGS. 7A and 7B show the results of the experiments. Irregularity of 10  $\mu\text{m}$  in height was drastically reduced as shown in FIG. 7B after the CMP treatment, compared with FIG. 7A before the CMP treatment.

[0039]

In addition, another treatment, for example, UV irradiation, oxygen plasma treatment, or the like in order to reform the first electrode surface may be carried out after the polishing.

[0040]

Next, an insulating film is formed over a whole surface of the substrate. (FIG. 2B) For the insulating film, a material that is different in etching rate from the material for the first bank is used.

Since the first bank has insulated between the electrodes already, a semiconductor film (polysilicon or amorphous silicon) may be formed instead of the insulating film as well. In addition, this insulating film becomes a second bank which covers a side-face of the first bank at the following step. In addition, by forming the insulating film just after polishing the first electrode surface, dust attachment to the first electrode surface is prevented. Dust may be attached to the first electrode surface during the substrate at the state of FIG. 2A is transported or installed to a vapor deposition system, which may cause short circuit. However, when the substrate is formed to be a state of FIG. 2B, even if dust is attached when the substrate is transported to outside the factory, the dust on an insulating film surface can be removed by etching at the following step and the first electrode surface can be kept clean.

[0041]

Subsequently, the insulating film is almost removed by anisotropic etching or etch back, and the second bank 12 which contacts only a side face of the first bank is formed and the first electrode surface is exposed. (FIG. 2C) Here, it is preferable that the surface be made a curved surface by wet etching or dry etching using a reactive ion and the second bank be formed according to a shape of the first bank in a self-aligning manner. Although the first bank side face formed by dry etching is easily to be rough, the second bank is formed to cover the rough surface of the first bank side face. In this manner, a sidewall type bank is formed. In addition, if a portion that has not yet been flattened by planarization treatment such as CMP appears on the first electrode surface, the portion can be covered with the second bank. When the second bank 12 is patterned, an etching condition or a material is appropriately set so as to have a selection ratio to the first bank, the first electrode and the insulating film 18.

[0042]

In addition, when the second bank is formed, the first electrode surface may be thin by etching. The first electrode surface can be kept a flat surface even if the surface is somewhat overetched since the surface has been flattened by CMP or the like in advance. In addition, in the case where the first electrode surface is overetched, a slight difference in level is formed at a portion contacts an edge portion of the second bank.

[0043]

Further, when the second bank is formed, the first bank formed of a material having a different etching rate from that of the second bank may be etched. In the case where the first bank is overetched, an upper edge portion thereof can be formed to be round.

[0044]

An example of combination of respective materials for the portions is as follows: a silicon nitride film for the insulating film 18; an ITO for the first electrode 13; a silicon oxide film for the first bank 11; and an organic resin film (acrylic, polyimide, or the like) for the second bank 12. The second bank is formed by O<sub>2</sub> plasma ashing. In the case of forming the second bank by O<sub>2</sub> plasma ashing, the number of total steps is not increased since the surface reforming of the first electrode 13 can be carried out by O<sub>2</sub> plasma at the same time. In addition, in the case of a top emission type display device, in the case where the first electrode is formed of a titanium nitride film, it is preferable that the work function be increased by changing the gas to gaseous chlorine and carrying out plasma treatment after the second bank is formed by O<sub>2</sub> plasma. In addition, According to the present invention, vacuum annealing can be carried out without exposing to air

after the bank is formed, and further, a layer containing an organic compound can be formed.

[0045]

Another example of combination of respective materials for the portions is as follows: a silicon nitride film for the insulating film 18; an ITO for the first electrode 13; a silicon oxide film for the first bank 11; and a polysilicon film for the second bank 12. The second bank is formed by etchant containing hydrofluoric acid, an  $S_2F_2$  gas, or the like. Further, as another example of combination of respective materials for the portions is as follows: a silicon nitride oxide film for the insulating film 18; an ITO for the first electrode 13; a silicon nitride film for the first bank 11; and a silicon oxide film (organic silane, for example, a silicon oxide film using tetraethoxysilane) for the second bank 12. The second bank is formed by anisotropic etching using RIE (Reactive Ion Etching). In the case where wet-etching is carried out on the second bank 12 as a silicon oxide film, mixed solution comprising ammonium hydrogen fluoride of 7.13 % and ammonium fluoride of 15.4 % (LAL500: produced by Stella Chemifa Corporation) may be used as an etchant. In addition, in order to form an upper edge portion of the second bank to have a curved surface, the second bank formed of a silicon oxide film may be formed by etching the silicon oxide film by gradually changing a  $CHF_3$  gas to a  $CF_4$  gas.

[0046]

In addition, in the case where the second bank is formed of a silicon nitride film, a  $CH_3F$  gas having high selectivity to a silicon oxide film or a silicon film is preferably used.

[0047]

Subsequently, the layer containing an organic compound 14 is formed by vapor deposition, and thereon a cathode which is the second electrode 15 is formed. It is to be noted that, in order to improve reliability, it is preferable that deaeration be carried out by vacuum heating (from 100°C to 250°C) just before forming the layer containing an organic compound 14. For example, in the case of using vapor deposition, deposition is carried out in a deposition chamber that is evacuated to a degree of vacuum of  $5 \times 10^{-3}$  Torr (0.665Pa) or smaller, preferably, from  $10^{-4}$  to  $10^{-6}$  Pa. In the vapor deposition, the organic compound has been vaporized by resistance heating in advance, and is scattered in the direction of the substrate by opening a shutter in depositing. Vaporized organic compounds are scattered upward and passing through an open area provided on a metal mask, deposited over the substrate. A structure shown in FIG. 2D can be obtained according to the above-described steps. Note that as a film-forming method for the layer containing an organic compound 14 and the second electrode 15, a resistance heating method that does no damage to the TFT 16 is preferable and ink-jetting, spin-coating, or the like may be used as well.

[0048]

In addition, in the case where the layer containing an organic compound is formed by ink-jetting or spin-coating using aqueous solution as material solution, as shown in FIG. 1B, a first bank 21 (and an insulating film 28) is formed of hydrophobic material and a second bank is formed of hydrophilic material so that the organic compound layer can be selectively formed. In this case, the layer containing an organic compound can be formed only on the second bank and an exposed surface of a first electrode 23. If the second bank is also formed of hydrophobic material, the film containing an organic compound formed over the first electrode becomes thin at the periphery while thick at the center, so that film uniformity can not be achieved. However, uniform thickness can be obtained over the first electrode by using hydrophilic material for the second bank.

[0049]

As the ink-jetting, a piezo-jetting type or a bubble-jetting type which is a discharge type by thermal bubble generation can be used.

[0050]

In FIG. 1B, reference numeral 20 is a substrate; 21 is the first bank; 22 is the second bank; 23 is the first electrode; 24 is a layer containing an organic compound; 25 is the second electrode; 26 is a TFT; and 28 is the insulating film. Although an example of forming the layer containing an organic compound 24 by coating is described here, the layer containing an organic compound 24 can be stacked with a film by vapor deposition. For example, poly(ethylenedioxythiophene)/polystyrenesulphonic acid (PEDOT/PSS), camphor sulfonic acid in polyaniline (PANI/CSA), PTPDES, Et-PTPDEK, or PPBA that serves as a hole injecting layer is spin-coated and baked, and after that, a light emitting layer, an electron transporting layer, and the like may be stacked thereon by vapor deposition. In this case, the hole injecting layer is formed over a predetermined portion in a self-aligning manner, and the light emitting layer, the electron transporting layer, and the like are formed by using an evaporation mask so that each end portion thereof does not coincide with each other.

[0051]

In addition, the first bank may be formed to have a hydrophobic surface by fluorination or the like instead of using hydrophobic material.

[0052]

In addition, although the example of using aqueous solution is described here, a material having an affinity to a material solution may be used as a material for the first bank and a material having a nonaffinity to the material solution may be used as a material for the second bank.

[0053]

(Embodiment Mode 2)

Here, an example of preventing electrostatic breakdown of a TFT by providing an antistatic layer during a manufacturing process of an active matrix display device is shown in FIGS. 3A to 3D. Note that in FIGS. 3A to 3D, the same components are denoted by the same numerals as of FIG. 1A.

[0054]

The TFT 16 and the first electrode 13 are formed over the substrate 10. Then, the first bank 11 is formed to cover the edge portion of the first electrode. (FIG. 3A)

[0055]

Subsequently, an insulating film is formed over the whole surface of the substrate, and an antistatic layer 30 is formed thereon. (FIG. 3B) By forming the antistatic layer 30, electrostatic breakdown can be prevented. Static electricity is easily charged on an insulating surface, therefore, there is a threat of adhesion of dust on the charged-surface or generating electrostatic discharge if it contacts another object.

[0056]

For forming the antistatic layer 30, a conductive polymer, for example, poly(ethylenedioxythiophene)/polystyrenesulphonic acid (PEDOT/PSS), camphor sulfonic acid in polyaniline (PANI/CSA), PTPDES, Et-PTPDEK, or PPBA may be spin-coated and baked. This antistatic layer 30 is removed at the following step. In addition, as the antistatic layer 30, a layer that is formed by dispersing particles of a metal such as silver, nickel, copper, or tin, or an oxide thereof into an acrylic resin, polyester resin, tetraethoxysilane, or the like, for example, a layer of acrylic including conductive particles of antimonious tin oxide having 0.2  $\mu\text{m}$  or smaller in particle diameter in the range of from 50 to 70 weight% may be formed as well.

[0057]

Next, after removing the antistatic layer 30, the second bank 12 is formed by anisotropic



etching (FIG. 3C). Note that, for reducing the number of steps, the second bank 12 may be formed by etching the antistatic layer 30 and the insulating film by the same etching method.

[0058]

In addition, in the case where the antistatic layer 30 and the first electrode are formed to contact each other, a surface state or work function of the first electrode may be changed by reacting to a material included in the antistatic layer 30. Therefore, an insulating layer is formed as a buffer layer between the antistatic layer and the first electrode according to the present invention, and further, the insulating film is etched to form a part of a bank that is the second bank 12 here.

[0059]

Next, the layer containing an organic compound 14 and a cathode which is the second electrode 15 are formed to be stacked by vapor deposition or coating. A structure shown in FIG. 3D can be formed through the above-described steps.

[0060]

Note that this embodiment mode can be freely combined with Embodiment Mode 1.

[0061]

(Embodiment Mode 3)

In Embodiment Mode 1, the example in which the second bank which covers a side face of the first bank is formed is described. Here, an example in which a second bank which covers all over a first bank is shown in FIG. 4A.

[0062]

In FIG. 4A, reference numeral 40 is a substrate; 41 is a first bank; 42 is a second bank; 43 is a first electrode; 44 is a layer containing an organic compound; 45 is a second electrode; 46 is a TFT; 47 is a power supply line; and 48a to 48c are insulating films.

[0063]

In addition, an example of a manufacturing process for obtaining the structure shown in FIG. 4A is illustrated in FIGS. 5A to 5D.

[0064]

First, the TFT 46 is manufactured over the substrate 40 having an insulating surface. The TFT 46 may be manufactured to be an n-channel type TFT or a p-channel type TFT by a known method. Note that reference numeral 46a is a channel formation region, 46b and 46c are a source region or a drain region, 46d is a gate electrode, 46e and 46f are a source electrode or a drain electrode, and 46g is a gate insulating film. A top gate type TFT is described here, however, the invention is not limited to this and a bottom gate type TFT may be used as well.

[0065]

Next, the first electrode 43 which serves as an anode is formed to partly overlap the electrode 46f of the TFT.

[0066]

Subsequently, an insulating film is formed by PCVD, sputtering, or coating over the whole surface, and patterning using photolithography technique is carried out to form the first bank 41. The first bank 41 covers an edge portion of the first electrode 43, the power supply line 47, and the electrodes 46e and 46f and insulates between electrodes. Described here is an example in which the first bank 41 is formed of an inorganic insulating film (a silicon oxide film, a silicon nitride oxide film, or the like) by coating.

[0067]

Next, an exposed surface of the first electrode 43 is polished or washed. FIG. 5A is a cross-sectional view of one pixel at this step.

[0068]

Subsequently, an insulating film is formed over the whole surface of the substrate. (FIG. 5B) For this insulating film, a material that has a same etching rate as a material for the first bank is used. Alternatively, for the insulating film, a material that has different in etching rate from a material for the first bank may be used.

[0069]

Next, the second bank 42 which covers the first bank 41 is formed by etch back or anisotropic etching. Simultaneously, the first electrode surface is exposed. (FIG. 5C) If the etch back is performed, the second bank 42 is formed while reflecting irregularity of the insulating film surface. Further, an upper edge portion of the second bank 42 can be formed to be more smooth than that of the first bank 41.

[0070]

Then, the layer containing an organic compound 44 is formed by vapor deposition and thereon, a cathode which is the second electrode 15 is formed thereon. A structure shown in FIG. 5D can be obtained through the above-described steps. Note that a resistance heating method that does no damage to the TFT 46 is preferable for a film-forming method for the layer containing an organic compound 44 and the second electrode 45, and Ink-jetting, spin-coating, or the like may be used as well.

[0071]

Note that this embodiment mode can be freely combined with Embodiment Mode 1 or Embodiment Mode 2.

[0072]

(Embodiment Mode 4)

In Embodiment Mode 1, the example in which the second bank which covers a side face of the first bank is described. Here, an example in which a first bank which covers only an electrode is shown in FIG. 4B. A submicron-size bank can be formed according to this embodiment mode.

[0073]

In FIG. 4B, reference numeral 50 is a substrate; 51 is a first bank; 52 is a second bank; 53 is a first electrode; 54 is a layer containing an organic compound; 55 is a second electrode; 56 is a TFT; and 58 is an insulating film.

[0074]

Here, the first bank 51 is formed of an oxide (alumina) that is obtained by carrying out oxidation treatment such as thermal oxidation or anodic oxidation on a metal electrode (an electrode containing aluminum as its main component). Therefore, the number of masks can be reduced since the first bank can also be formed in a self-aligning manner. Further, an upper surface of the first bank obtained by oxidation can be formed to be further smaller so that high definition can be achieved. In addition, bank size can be extremely small, thereby an bank area occupied on the whole region of the pixel becomes smaller to improve the aperture ratio.

[0075]

After the first electrode 53 is formed over the insulating film 58, an electrode (a source electrode or a drain electrode) of the TFT is formed. After that, an oxide film is formed on the surface by oxidizing the electrode of the TFT. The first bank 51 serves as the oxide film of the electrode, which can achieve a size of 0.1  $\mu\text{m}$  or smaller.

[0076]

Subsequently, an exposed surface of the first electrode 53 is polished or washed. Then, an

insulating film is formed over the whole surface of the substrate. For this insulating film, a material that is different in etching rate from a material of the first bank is used. In addition, since the first bank has insulated already between the electrodes, a semiconductor film (polysilicon, amorphous silicon, or the like) may be formed instead of the insulating film as well. This insulating film becomes the second bank which covers a side face of the first bank at the following step.

[0077]

Next, the insulating film is almost all removed by anisotropic etching or etch back to form the second bank 52 which contacts only a side face of the first bank, and simultaneously, expose a first electrode surface. Here, it is preferable that the second bank be formed to be a curved surface in a self-aligning manner by wet etching. In this manner, a sidewall type bank is formed. Although insulating between pixels can be performed only by the first bank, if the first bank is formed of a metal oxide, the thickness of an upper edge portion and a bottom edge portion of the first bank tend not to be uniform, that is, tend to be an inverted taper shape, thereby poor coverage easily occurs. According to this embodiment mode, poor coverage of the layer containing an organic compound having thin thickness which is formed later can be prevented by covering with the second bank the side face of the first bank which tends not to be uniform, so that reliability is improved.

[0078]

In addition, as described in Embodiment Mode 4, the second bank which covers all over the first bank 51 may be formed as well.

[0079]

Subsequently, the layer containing an organic compound 54 is formed by vapor deposition, and thereon a cathode which is the second electrode 55 is formed. A structure shown in FIG. 4B can be obtained through the above-described steps. Note that a resistance heating method that does no damage to the TFT 56 is preferable for a film-forming method for the layer containing an organic compound 54 and the second electrode 55 and Ink-jetting, spin-coating, or the like may be used as well.

[0080]

Note that this embodiment mode can be freely combined with Embodiment Mode 1, Embodiment Mode 2, or Embodiment Mode 3.

[0081]

(Embodiment Mode 5)

In the case of manufacturing a TFT and an EL element over a substrate, it is possible that an installation site of equipment for manufacturing a TFT and an installation site of equipment for forming an EL element are separated from each other. For example, to separate buildings in which respective equipment are installed, or to install a factory itself in different sites can be considered.

[0082]

In the case of separating, necessity to transport a substrate between these installation sites occurs. In addition, in transporting the substrate between the installation sites, there is a risk of electrostatic breakdown and adhesion of dust. A TFT is extremely weak to electrostatic and characteristic of a TFT varies due to electrostatic breakdown or electrostatic.

[0083]

Here, examples of a manufacturing system for a light emitting device which is appropriate to the case where the installation site (a first site) of the equipment for manufacturing a TFT and the

installation site (a second site) of the equipment for forming an EL element are separated are illustrated in FIGS. 6A and 6B.

[0084]

FIG. 6A illustrates an example of a flow of the present invention.

[0085]

First, a substrate is transported to the first site and a TFT is formed over the substrate. Next, an anode of a light emitting element is formed. Then, a protective film for protecting an anode surface is formed. This protective film is formed using a single layer formed of an insulating material or an antistatic material, or a stacked layer thereof.

[0086]

Next, the substrate is transported or delivered from the first site.

[0087]

Then, the substrate is transported to the second site and a bank for insulating between the anodes is formed. Note that a part of an anode surface is exposed simultaneously with the formation of the bank. If this bank is formed by means of etching the protective film formed in the first site, the number of steps can be reduced.

[0088]

Next, an organic compound layer and a cathode are formed sequentially, and then sealing is performed. Then, a completed light emitting device is transported from the second site.

[0089]

According to the system having such process flow, even if the time spent on the process from the formation of the anode to the formation of the organic compound layer becomes long, a yield can be improved since dust is attached to the protective film during the transportation. The number of dust attaching to the anode surface is considered to increase with time at a state where the anode surface is exposed, therefore, it is important that the organic compound layer is formed with reducing the time spent on exposing the anode surface as much as possible.

[0090]

That is, according to the process flow shown in FIG. 6A, it is possible that a substrate is transported before forming a bank, and just after the bank is formed, vapor deposition can be carried out.

[0091]

In addition, it is also possible to stock at a stage in which the protective film is formed.

[0092]

In addition, by separating the sites, the first site can be enhanced its cleanliness and a TFT having high electric characteristics can be manufactured without being mixed an alkali metallic element that has a decisive influence on the electric characteristics of the TFT during the process.

[0093]

FIG. 6B illustrates an example of another flow.

[0094]

First, a substrate is transported to the first site and a TFT is formed over the substrate. Next, an anode of a light emitting element is formed. Then, a bank for insulating the anodes is formed. A part of an anode surface is exposed simultaneously with forming the bank. Next, a protective film for protecting the anode surface is formed. This protective film is formed using a single layer formed of an insulating material or an antistatic material, or a stacked layer thereof.

[0095]

Next, the substrate is transported or delivered from the first site.

[0096]

Then, the substrate is transported to the second site and the protective film is removed. Alternatively, a second bank as described in Embodiment Modes 1 to 4 may be formed by carrying out anisotropic etching on the protective layer.

[0097]

Next, an organic compound layer and a cathode are formed sequentially, and then sealing is performed. Then, a completed light emitting device is transported from the second site.

[0098]

In addition, this embodiment mode may be applied to a case where the first site is a first factory and the second site is a second factory as well.

[0099]

As for the present invention having the above-described structure, further detail description is performed by the following embodiments.

[0100]

(Embodiments)

[Embodiment 1]

In this embodiment, shown in FIGS. 8A and 8B is an example in which a light emitting device (having a top emission structure) provided with a light emitting element having an organic compound layer as a light emitting layer, over a substrate having an insulating surface.

[0101]

Note that FIG. 8A is a top view showing the light emitting device and FIG. 8B is a cross-sectional view taken along a line A-A' of FIG. 8A. Reference numeral 1101 indicated by a dotted line is a source signal line driver circuit; 1102 is a pixel portion; and 1103 is a gate signal line driver circuit. Further, reference numeral 1104 is a transparent sealing substrate; and 1105 is a first sealant. Inside surrounded by the first sealant 1105 is filled with a transparent second sealant 1107. Note that the first sealant 1105 contains a gap material for keeping a space between substrates.

[0102]

Note that reference numeral 1108 is a wire for transmitting a signal to be input to the source signal line driver circuit 1101 and the gate signal line driver circuit 1103, and receives a video signal and a clock signal from a FPC (flexible printed circuit) 1109 which is an external input terminal. Note that although only the FPC is illustrated here, a printed wiring board (PWB) may be attached to this FPC.

[0103]

Subsequently, a cross-sectional structure is described with reference to FIG. 8B. A driver circuit and a pixel portion are formed over the substrate 1110. Here, the source signal line driver circuit 1101 as the driver circuit and the pixel portion 1102 are illustrated.

[0104]

Note that the source signal line driver circuit 1101 is formed of a CMOS circuit that is a combination of an n-channel type TFT 1123 and a p-channel type TFT 1124. The TFT that constitutes the driver circuit may be, alternatively, formed of a known CMOS circuit such as a PMOS circuit or an NMOS circuit. In addition, although a driver circuit formed over a substrate that is referred to a driver integrated type is described in this embodiment, the present invention is not limited to this and the driver circuit may be formed outside not over a substrate as well. In addition, a structure of the TFT using a polysilicon film as an active layer is not particularly

limited, and it may be either a top gate type TFT or a bottom gate type TFT.

[0105]

In addition, the pixel portion 1102 is formed with a plurality of pixels each of which includes a switching TFT 1111, a current controlling TFT 1112, and a first electrode (anode) 1113 which is electrically connected to a drain of the current controlling TFT 1112. The current controlling TFT 1112 may be either an n-channel type TFT or a p-channel type TFT, however, when it is connected to an anode, it is preferable to be a p-channel type TFT. In addition, a storage capacitor (not shown) is preferably provided appropriately. Here, only the cross-sectional structure of only one pixel among thousands of provided pixels is shown and an example in which two TFTs are used in the one pixel is described. However, three or more TFTs may be used appropriately as well.

[0106]

Since the first electrode 1113 is directly connected to the drain of the TFT here, it is preferable that a lower layer of the first electrode 1113 be a material layer that can have an ohmic contact with the drain containing silicon and an uppermost layer thereof which contacts an organic compound layer be a material layer that has a large work function. For example, in the case of a three-layer structure of a titanium nitride film, a film containing aluminum as its main component, and a titanium nitride film, resistance as a wiring can be reduced and a favorable ohmic contact with the drain can be obtained, and besides, it can serve as an anode. Further, the first electrode 1113 may be formed of a single layer such as a titanium nitride film, a chromium film, a tungsten film, a Zn film, a Pt film or the like, or a stacked layer of three or more layers as well.

[0107]

In addition, insulators 1114a and 1114b (referred to as a bank or the like) are formed on both ends of the first electrode (anode) 1113. The insulators 1114a and 1114b may be formed of either an organic resin film or an insulating film containing silicon. The insulators 1114a and 1114b may be formed according to the above-described Embodiment Mode 3. Here, the insulator 1114a is formed of a silicon oxide film and the insulator 1114b is formed of a positive type photosensitive acrylic resin film, which are formed into the shape as shown in FIGS. 8A and 8B.

[0108]

To improve coverage, an upper edge portion or a bottom edge portion of the insulator 1114b is formed to have a curved surface having curvature. For example, in the case where a positive type photosensitive acrylic is used as a material for the insulator 1114b, it is preferable that only the upper edge portion of the insulator 1114b have a curved surface having radius of curvature (from 0.2  $\mu\text{m}$  to 3  $\mu\text{m}$ ). In addition, either a negative type that becomes an insoluble in etchant by photosensitive light or a positive type that becomes dissoluble in etchant by light can be used as the insulator 1114b.

[0109]

In addition, on the first electrode (anode) 1113, a layer containing an organic compound 1115 is selectively formed by vapor deposition using an evaporation mask or ink-jetting. Further, a second electrode (cathode) 1116 is formed on the layer containing an organic compound 1115. As the cathode, a material having a small work function (for example, Al, Ag, Li, Ca, or an alloy thereof such as MgAg, MgIn, AlLi, CaF<sub>2</sub>, or CaN) may be used. Here, in order to transmit light emission, a stacked layer of a metal thin film having a thin thickness and a transparent conductive film (for example, an indium oxide-tin oxide alloy (ITO), an indium

oxide-zinc oxide alloy ( $\text{In}_2\text{O}_3\text{-ZnO}$ ), zinc oxide ( $\text{ZnO}$ ), or the like) is used as the second electrode (cathode) 1116. In this manner, a light emitting element 1118 structured by the first electrode (anode) 1113, the layer containing an organic compound 1115, and the second electrode (cathode) 1116 is formed. Since the light emitting element 1118 emits white light in this example here, a color filter (for ease of explanation, an overcoat layer is not shown here) having a coloring layer 1131 and a light shielding layer (BM) 1132 is provided.

[0110]

Alternatively, if respective organic compound layers that can obtain R, G, and B emission are formed selectively, full color display can be obtained without using a color filter.

[0111]

In addition, a transparent protective layer 1117 is formed in order to seal the light emitting element 1118. As a transparent protective stacked layer, a silicon nitride film, a silicon oxide film, a silicon nitride oxide film (an  $\text{SiNO}$  film (a relative proportion:  $\text{N}>\text{O}$ ), or an  $\text{SiON}$  film (a relative proportion:  $\text{N}<\text{O}$ )), or a thin film containing carbon as its main component (for example, a DLC film, or a CN film) formed by sputtering or CVD can be used. In this embodiment, a film formed by a silicon target under an atmosphere comprising nitrogen and argon, namely, a silicon nitride film that has high blocking effect against impurity such as moisture, alkali metal, or the like is used as the transparent protective layer 1117. In addition, since light emission is passed through the transparent protective stacked layer, the total thickness of the transparent protective stacked layer is preferably thin as much as possible.

[0112]

In addition, in order to seal the light emitting element 1118, the sealing substrate 1104 is bonded by the first sealant 1105 and the second sealant 1107 under an inert gas atmosphere. Note that an epoxy resin is preferably used as the first sealant 1105 and the second sealant 1107. Further, it is also preferable that the first sealant 1105 and the second sealant 1107 do not transmit moisture or oxygen as much as possible.

[0113]

In addition, in this embodiment, a plastic substrate formed of FRP (fiberglass-Reinforced Plastics), PVF (polyvinylfluoride), mylar, polyester, an acrylic resin, or the like, in addition to a glass substrate or a quartz substrate can be used as a material which constitutes the sealing substrate 1104. Further, after the sealing substrate 1104 is bonded using the first sealant 1105 and the second sealant 1107, it is also possible to seal using a third sealing material so as to cover a side face (exposed face).

[0114]

By encapsulating the light emitting element as described above, it becomes possible that the light emitting device can be blocked completely from outside and penetration of a material such as moisture or oxygen from outside that causes deterioration of the organic compound layer can be prevented. Consequently, a light emitting device having high reliability can be obtained.

[0115]

In addition, if a transparent conductive film is used as the first electrode 1113, a both-surfaces light emitting type light emitting device can be manufactured.

[0116]

In addition, described in this embodiment is the example of the structure in which the layer containing an organic compound is formed on the anode and on the layer containing an organic compound, the cathode which is the transparent electrode is formed (hereinafter referred to as a "top emission structure") is described. However, the following structure may be

employed as well in which a light emitting element is included in which a layer containing an organic compound is formed on an anode and an the layer containing an organic compound, a cathode is formed and light emission generated in the layer containing an organic compound is taken out in the direction of a TFT through the anode that is a transparent electrode (hereinafter referred to as a "bottom emission structure").

[0117]

Here, an example of a light emitting device having a bottom emission structure is shown in FIGS. 9A and 9B.

[0118]

Note that FIG. 9A is a top view showing the light emitting device and FIG. 9B is a cross-sectional view taken along a line A-A' of FIG. 9A. Reference numeral 1201 indicated by a dotted line is a source signal line driver circuit; 1202 is a pixel portion; and 1203 is a gate signal line driver circuit. Further, reference numeral 1204 is a sealing substrate; and 1205 is a sealant containing a gap material for keeping a space of an enclosed space, and inside surrounded by the sealant 1205 is filled with an inert gas (typically, nitrogen). A trace quantity of moisture in the inside space surrounded by the sealant 1205 is removed by a desiccant 1207, and the space is made sufficiently dry.

[0119]

Note that reference numeral 1208 is a wire for transmitting signals to be input to the source signal line driver circuit 1201 and the gate signal line driver circuit, and receives a video signal and a clock signal from a FPC (flexible printed circuit) 1209 which is an external input terminal.

[0120]

Subsequently, a cross sectional structure thereof is described with reference to FIG. 9B. A driver circuit and a pixel portion are formed over a substrate 1210, and the source signal line driver circuit 1201 as the driver circuit and the pixel portion 1202 are shown here. The source signal line driver circuit 1201 is formed of a CMOS circuit that is a combination of an n-channel type TFT 1223 and a p-channel type TFT 1224.

[0121]

In addition, the pixel portion 1202 is formed with a plurality of pixels each of which includes a switching TFT 1211, a current controlling TFT 1212, and a first electrode (anode) 1213 formed of a transparent conductive film which is electrically connected to a drain of the current controlling TFT 1212.

[0122]

Here, the first electrode 1213 is formed so as to partially overlap a connecting electrode and forms a structure in which the first electrode 1213 is electrically connected to a drain region of the TFT through the connecting electrode. It is preferable that the first electrode 1213 be formed of a conductive film that has transparency and a large work function (for example, ITO (an indium tin oxide),  $\text{In}_2\text{O}_3\text{-ZnO}$  (an indium oxide-zinc oxide alloy), zinc oxide (ZnO), or the like).

[0123]

In addition, insulators 1214a and 1214b (referred to as a bank or the like) are formed on both edges of the first electrode (anode) 1213. To improve coverage, an upper edge portion or a lower edge portion of the insulating substance 1214b is formed to have a curved surface having a curvature. The insulators 1214a and 1214b can be formed according to Embodiment Mode 1 to be a side wall type insulator.



[0124]

In addition, on the first electrode (anode) 1213, a layer containing an organic compound 1215 is selectively formed by vapor deposition using an evaporation mask or ink-jetting. Further, on the layer containing an organic compound 1215, a second electrode (cathode) 1216 is formed. For the cathode, a small work function material (for example Al, Ag, Li, Ca, or an alloy thereof such as MgAg, MgIn, AlLi, CaF<sub>2</sub>, or CaN) may be used. In this manner, a light emitting element 1218 comprising the first electrode (anode) 1213, the layer containing an organic compound 1215 and the second electrode (cathode) 1216 is formed. The light emitting element 1218 emits light in a direction indicated by an arrow in FIG. 9B. Here, the light emitting element 1218 is a type of light emitting element which can achieve single color emission of R, G, or B, and full color is achieved by three light emitting elements in which respective layer containing an organic compound for obtaining light emission of R, G, and B are selectively formed.

[0125]

In addition, a protective layer 1217 is formed in order to seal the light emitting element 1218.

[0126]

In addition, in order to seal the light emitting element 1218, the sealing substrate 1204 is bonded to the substrate by the sealant 1205 under an inert gas atmosphere. A depressed portion has been formed on a surface of the sealing substrate 1204 by sandblast in advance, and a desiccant 1207 is attached to the depressed portion. Note that it is preferable to use an epoxy resin for the sealant 1205. In addition, it is also preferable that the sealant 1205 does not transmit moisture or oxygen as much as possible.

[0127]

In addition, in this embodiment, as a material for the sealing substrate 1204 having the depressed portion, a plastic substrate formed of FRP (Fiberglass-Reinforced Plastics), PVF (polyvinyl fluoride), mylar, polyester, an acrylic resin or the like, in addition to a metal substrate, a glass substrate or a quartz substrate can be used. Alternatively, sealing may also be performed by using a metal can attached a desiccant to its inside.

[0128]

Note that this embodiment can be freely combined with any one of Embodiment Modes 1 to 5.

[0129]

[Embodiment 2]

In this embodiment, described is an example in which such a device that has various functions of materials and a division of function within a stacked-layer structure in addition to improve the mobility of carriers by relaxing an energy barrier in an organic compound film.

[0130]

The technique of inserting a carrier injection layer largely contributes with respect to the relaxation of the energy barrier in the stacked-layer structure. That is, by inserting a material that relaxes the energy barrier into an interface between the stacked-layer structure having a large energy barrier, the energy barrier can be designed in a staircase pattern. Consequently, a carrier injection property from the electrode can be improved and a driving voltage can surely be reduced to a certain extent. However, there is a problem in that the number of organic interfaces is increased as the number of layers is increased. This seems to be a reason why a single layer structure rather holds top data of driving voltage and power efficiency. In other words, by

overcoming this problem, the stacked-layer structure can achieve the driving voltage and power efficiency of the single layer structure while taking an advantage of the stacked-layer structure (various types of materials can be combined without complicated design of molecules).

[0131]

According to this embodiment, therefore, in the case where an organic compound film having a plurality of functional regions is formed between an anode and a cathode of a light emitting element, formed is a structure having a mixed region having a material which constitutes a first functional region and a material which constitutes a second functional region is formed between the first functional region and the second functional region, which is different from the conventional stacked-layer structure having a distinct interface.

[0132]

Further, the case where a material which is capable of converting triplet excitation energy into light emission is added to the mixed region as a dopant is also included. In addition, in forming the mixed region, the mixed region may have a concentration gradient.

[0133]

By applying such structure, it is considered that the energy barrier which is provided between the functional regions is reduced compared with the conventional structure, thereby enhancing the carrier injection property. That is, the energy barrier between functional regions is relaxed by forming the mixed region. Accordingly, the driving voltage can be reduced and decrease in luminance can be prevented.

[0134]

From the foregoing, according to this embodiment, in the manufacture of a light emitting element which at least includes a region (first functional region) in which a first organic compound can develop function and a region (second functional region) in which a second organic compound different from the material constituting the first functional region can develop function, and of a light emitting device having the light emitting element, a mixed region having the organic compound constituting the first functional region and the organic compound constituting the second functional region is manufactured between the first functional region and the second functional region.

[0135]

In a film formation apparatus, an organic compound film having a plurality of functional regions is formed in one deposition chamber, and accordingly a plurality of evaporation sources is provided.

[0136]

First, a first organic compound is deposited. Note that the first organic compound, which has previously been vaporized by resistance heating, is scattered in the direction of a substrate by opening a shutter at the time to start vapor deposition. Thus, a first functional region 610 shown in FIG. 10A can be formed.

[0137]

Next, while depositing the first organic compound, a first shutter is opened, and a second organic compound is deposited. Further, the second organic compound, which has also previously been vaporized by resistance heating, is scattered in the direction of the substrate by opening a second shutter at the time to start vapor deposition. At this stage, a first mixed region 611 formed of the first organic compound and the second organic compound can be formed.

[0138]

Then, after a while, only the first shutter is closed, and the second organic compound is

deposited. In this manner, a second functional region 612 can be formed.

[0139]

Note that described in this embodiment is the case where the mixed region is formed by depositing simultaneously two types of organic compounds is described, however, it is also possible that the second organic compound is deposited after depositing the first organic compound under the evaporation atmosphere so that a mixed region is formed between the first functional region and the second functional region.

[0140]

Subsequently, while depositing the second organic compound, a third shutter is opened, and a third organic compound is deposited. Note that the third organic compound, which has also previously been vaporized by resistance heating, is scattered in the direction of the substrate by opening the shutter at the time to start vapor deposition. At this stage, a second mixed region 613 formed of the second organic compound and the third organic compound can be formed.

[0141]

Then, after a while, only the second shutter is closed, and the third organic compound is deposited. In this manner, a third functional region 614 can also be formed.

[0142]

Finally, a cathode is formed so that a light emitting element is completed.

[0143]

Further, as another organic compound film, as shown in FIG. 10B, after a first functional region 620 is formed by using a first organic compound, a first mixed region 621 formed of the first organic compound and a second organic compound is formed, and then using the second organic compound, a second functional region 622 is formed. Then, in the step of forming the second functional region 622, the third shutter is temporarily opened to deposit simultaneously a third organic compound. In this manner, a second mixed region 623 is formed.

[0144]

Then, after a while, the second functional region 622 is formed again by closing the third shutter. Then, a cathode is formed, thereby completing a light emitting element.

[0145]

Since an organic compound film having a plurality of functional regions can be formed in one deposition chamber, impurity is prevented from contaminating the interface between the functional regions, and a mixed region can be formed at the interface between the functional regions. As a result of this, a light emitting element having a plurality of functions can be manufactured without showing distinct stacked-layer structure (namely, without having a distinct organic interface).

[0146]

Further, when a film formation apparatus which can perform vacuum annealing before depositing, during depositing, or after depositing is used, intermolecular state in the mixed region can be more strongly fit by performing vacuum annealing during the deposition. Accordingly, the driving voltage can be further reduced and decreasing in luminance can be prevented. In addition, annealing (deaeration) may be carried out after the film formation, so that impurity such as oxygen or moisture in the organic compound layer formed over the substrate can be further removed, and a high-density and high-purity organic compound layer can be formed.

[0147]

Note that this embodiment can be freely combined with any one of Embodiment Modes 1 to 5 and Embodiment 1.

[0148]

[Embodiment 3]

By implementing the present invention, various modules (an active matrix type liquid crystal module, an active matrix type EL module and an active matrix type EC module) can be completed. That is, by implementing the present invention, all of the electronic apparatuses incorporated those modules can be completed.

[0149]

As such electronic apparatuses, there are a video camera, a digital camera, a head mount display (goggle type display), a car navigation, a projector, a car stereo, a personal computer, a portable information terminal (a mobile computer, a portable telephone, an electronic book, or the like), or the like. FIGS. 11A to 12C show examples thereof.

[0150]

FIG. 11A is a personal computer which includes a main body 2001, an image input portion 2002, a display portion 2003, a keyboard 2004, and the like. A top surface shape of a bank can be reduced according to the present invention, thereby high-definition display can be realized.

[0151]

FIG. 11B is a video camera which includes a main body 2101, a display portion 2102, a voice input portion 2103, operating switches 2104, a battery 2105, an image receiving portion 2106, or the like.

[0152]

FIG. 11C is a mobile computer which includes a main body 2201, a camera portion 2202, an image receiving portion 2203, an operating switch 2204, a display portion 2205, or the like.

[0153]

FIG. 11D is a player using a recording medium recorded with a program (hereinafter referred to as a recording medium) which includes a main body 2401, a display portion 2402, a speaker portion 2403, a recording medium 2404, an operating switch 2405, or the like. Note that this player uses DVD (Digital Versatile Disc), CD, or the like as a recording medium and can be used for enjoying music, movie, game or Internet.

[0154]

FIG. 11E is a digital camera which includes a main body 2501, a display portion 2502, an eye piece 2503, operating switches 2504, an image receiving portion (not shown), or the like.

[0155]

FIG. 12A is a portable telephone which includes a main body 2901, a voice output portion 2902, a voice input portion 2903, a display portion 2904, an operating switch 2905, an antenna 2906, an image input portion (CCD, image sensor or the like) 2907, or the like. A top surface shape of a bank can be reduced according to the present invention, so that high-definition display can be realized.

[0156]

FIG. 12B is a portable book (electronic book) which includes a main body 3001, display portions 3002 and 3003, a recording medium 3004, an operating switch 3005, an antenna 3006, or the like.

[0157]

FIG. 12C is a display which includes a main body 3101, a support base 3102, a display portion 3103, or the like.

[0158]

Incidentally, the display shown in FIG. 12C is of a screen size of middle or small type or large type, for example, a screen size from 5 to 20 inches. In addition, in order to form the display portion of this size, it is preferable to use a substrate having a side length of 1 m and carry out mass production by taking multiple patterns.

[0159]

As set forth above, the application range of the present invention is extremely wide and the present invention is applicable to a method of fabricating electronic apparatuses in all fields. In addition, the electronic apparatuses of this embodiment can be realized by combining with any one of Embodiment Modes 1 to 5, Embodiment 1, or Embodiments 2.

[0160]

[Embodiment 4]

In the electronic apparatuses described in Embodiment 3, a module on which an IC including a controller, a power supply circuit, or the like are mounted is equipped with a panel with a light emitting element is sealed. Both the module and the panel correspond to one mode of a light emitting device. In this Embodiment, a specific structure of a module is described.

[0161]

FIG. 13A shows an external view of a module in which a panel 800 is mounted with a controller 801 and a power supply circuit 802. The panel 800 is provided with a pixel portion 803 in which a light emitting element is provided in each pixel, a scan line driver circuit 804 for selecting a pixel in the pixel portion 803, and a signal line driver circuit 805 for supplying a video signal to the selected pixel.

[0162]

In addition, a controller 801 and the power supply circuit 802 are provided with a printed substrate 806, and various kinds of signals and a power supply voltage output from the controller 801 or the power supply circuit 802 are supplied through a FPC 807 to the pixel portion 803, the scan line driver circuit 804, and the signal line driver circuit 805 in the panel 800.

[0163]

The power supply voltage and the various kind of signals are supplied to the printed circuit 806 through an interface (I/F) 808 in which a plurality of input terminals are arranged.

[0164]

Note that although the printed substrate 806 is mounted on the panel 800 with FPC in this embodiment, the present invention is not limited to this structure. The controller 801 and the power supply circuit 802 may be provided directly on the panel 800 with a COG (Chip on Glass) method.

[0165]

In addition, in the printed circuit 806, there is a case that a capacitance formed between lead wires, a resistance of a wire itself, or the like causes a noise to a power supply voltage or a signal, or a delay of a signal rise. Therefore, various kinds of elements such as a capacitor and a buffer may be provided in the printed substrate 806 to prevent the noise of the power supply voltage or the signal, the delay of a signal rise, or the like.

[0166]

FIG. 13B shows a block diagram showing a structure of the printed substrate 806. Various kinds of signals and a power supply voltage supplied to the interface 808 are supplied to the controller 801 and the power supply circuit 802.

[0167]

The controller 801 includes an A/D converter 809, a phase locked loop (PLL) 810, a

control-signal generating portion 811, and SRAMs (Static Random Access Memories) 812 and 813. Note that although the SRAM is used in this embodiment, instead of the SRAM, an SDRAM may be used and a DRAM (Dynamic Random Access Memory) may also be used if it is possible to write and read data at high speed.

[0168]

Video signals supplied through the interface 808 are subjected to a parallel-serial conversion in the A/D converter 809 to be input to the control-signal generating portion 811 as video signals corresponding to respective colors of R, G, and B. In addition, based on various kinds of signals supplied through the interface 808, a Hsync signal, a Vsync signal, a clock signal CLK, and an alternating current voltage (AC cont) are generated in the A/D converter 809 to be input to the control signal generating portion 811.

[0169]

The phase-locked loop 810 has a function to synchronize the phase of the frequency of the various kinds of signals supplied through the interface 808 with the phase of the operating frequency of the control-signal generating portion 811. The operating frequency of the control-signal generating portion 811 is not necessarily the same as the frequency of the various kinds of signals supplied through the interface 808, however, the operating frequency of the control-signal generating portion 811 is adjusted in the phase-locked loop 810 so as to be synchronized with each another.

[0170]

The video signal input to the control-signal generating portion 811 is once written to and held in the SRAMs 812 and 813. The control-signal generating portion 811 reads the video signals corresponding to all the pixels, one bit by one bit, among all the bits of video signals which have been held in the SRAM 812, and supplies to the signal line driver circuit 805 in the panel 800.

[0171]

In addition, the control signal generating portion 811 supplies information concerning a period during which the light emitting element of each bit emits light, to the scan line driver circuit 804 in the panel 800.

[0172]

In addition, the power supply circuit 802 supplies a predetermined power supply voltage to the signal line driver circuit 805, the scan line driver circuit 804, and the pixel portion 803 in the panel 800.

[0173]

Next, a specific configuration of the power supply circuit 802 is described with reference to FIG. 14. The power supply circuit 802 of this embodiment comprises a switching regulator 854 using four switching regulator controls 860 and a series regulator 855.

[0174]

Generally, a switching regulator is small in size and light in weight as compared to a series regulator, and can increase voltage and invert between positive and negative in addition to decreasing voltage. On the other hand, the series regulator is used only for decreasing voltage, and has a well output voltage accuracy as compared to the switching regulator and hardly causes ripples or noises. The power supply circuit 802 of this embodiment uses a combination of the both.

[0175]

The switching regulator 854 shown in FIG. 14 includes switching regulator controls

(SWRs) 860, attenuators (ATTs) 861, transformers (Ts) 862, an inductor (L) 863, a reference power supply (Vref) 864, an oscillator circuit (OSC) 865, a diode 866, a bipolar transistor 867, a varistor 868, and a capacitor 869.

[0176]

By transforming a voltage of an external Li-ion battery (3.6 V) or the like in the switching regulator 854, a power supply voltage to be supplied to a cathode and a power supply voltage to be supplied to the switching regulator 854 are generated.

[0177]

In addition, the series regulator 855 includes a band-gap circuit (BG) 870, an amplifier 871, operational amplifiers 872, a current source 873, varistors 874 and a bipolar transistor 875, and is supplied with a power supply voltage generated in the switching regulator 854.

[0178]

In the series regulator 855, using the power supply voltage generated in the switching regulator 854, based on a constant voltage generated in the band-gap circuit 870, a direct current power supply voltage to be supplied to a wire (current supply line) for supplying current to anodes of respective light emitting elements of colors is generated.

[0179]

Note that the current source 873 is used in the case of a driving method to write a video signal current to a pixel. In this case, a current generated in the current source 873 is supplied to the signal line driver circuit 805 in the panel 800. Note that in the case of a driving method to write a video signal voltage to a pixel, the current source 873 is not necessarily provided.

[0180]

Note that the switching regulator, the OSC, the amplifier and the operation amplifier can be formed using a TFT.

[0181]

Note that this embodiment can be freely combined with any one of Embodiment Modes 1 to 5, and Embodiments 1 to 3.

[0182]

[Effect of the Invention]

According to the present invention, poor coverage can be reduced by means of covering the side face or the upper surface with a second bank even if a difference in level in the cross-sectional shape of a first bank is large. Further, since the upper surface shape of a bank can be formed to be small, higher-definition display can be realized.

[0183]

Further, according to the present invention, electrostatic breakdown or adhesion of dust that is frequently occur in transporting a substrate between manufacturing equipment or installation sites of the equipment can be prevented.

[BRIEF DESCRIPTION OF THE DRAWINGS]

FIG. 1 are views showing cross-sectional structures according to Embodiment Mode 1;

FIG. 2 are views showing steps according to Embodiment Mode 1;

FIG. 3 are views showing steps according to Embodiment Mode 2;

FIG. 4 are views showing cross-sectional structures according to Embodiment Mode 3 and Embodiment Mode 4;

FIG. 5 are views showing steps according to Embodiment Mode 3;

FIG. 6 are flow charts according to Embodiment Mode 5;

FIG. 7 are graphs showing the comparison of irregularity before and after CMP;

FIG. 8 are a top view and a cross-sectional view according to Embodiment 1;  
FIG. 9 are a top view and a cross-sectional view according to Embodiment 1;  
FIG. 10 are diagrams showing device structures (Embodiment 2);  
FIG. 11 are diagrams showing examples of electronic apparatuses (Embodiment 3);  
FIG. 12 are diagrams showing examples of electronic apparatuses (Embodiment 3);  
FIG. 13 are views showing a module (Embodiment 4);  
FIG. 14 is a block diagram (Embodiment 4);



[Document Name]     Abstract

[Summary]

[Problem]     Conventionally, there have been problems that high resolution is difficult to be achieved since an extremely narrow-width bank can not be formed, and aperture ratio as a light emitting element is low. In addition, there is a threat of electrostatic breakdown or adhesion of dust during the transportation of a substrate provided with an anode to the equipment for depositing EL material. In view of the foregoing, a first bank formed of an inorganic insulating film is formed, and an insulating film is formed thereon, then, a second bank in contact with a side face of the first bank by carrying out etch back, and then, a side wall bank is formed. For preventing electrostatic discharge damage, an antistatic layer is formed, and the substrate is transported, then, the antistatic layer is removed to form the second bank.

[Solving Means]     In view of the foregoing, a first bank 11 formed of an inorganic insulating film is formed, an insulating film is formed thereon, and then etch back is performed to form a second bank 12 which is contacts a side face of the first bank, thereby a side wall bank is formed. For preventing electrostatic breakdown, an antistatic layer is formed and the substrate is transported, and then, the antistatic layer is removed to form the second bank 12.

[Selected drawing]     FIG. 1